EFFECTS OF LIVESTOCK GRAZING ON A COMMUNITY OF SPECIES AT RISK OF EXTINCTION IN THE SAN JOAQUIN VALLEY, CALIFORNIA

Annual Report[1]

19 December 2002

Summary

This report contains a summary of results from the sixth year of plant and animal censuses on the Lokern Natural Area study site. In 2002, we again had a below average year of rainfall, which resulted in virtually no herbaceous plant growth on the study area. As a result, no cattle were placed on the study site in 2002. Plant studies continue with no significant effect of treatment visible yet. In 2002, similar to last year, sage sparrow numbers were again low, having steadily declined since 1997 irrespective of whether areas were grazed or not. Numbers of western meadowlarks peaked in 1999, and they now are abundant on controls but not treatments. Horned lark numbers continue high on treatment plots and low on controls. Side-blotched lizards and western whiptails continue to be found throughout the study area with little difference between treatment and control plots. Blunt-nosed leopard lizards remain scarce but their numbers have increased, especially on Section 27. Nocturnal rodent numbers increased from 2001 and they continue to be spread throughout the study area in 2002. Short-nosed kangaroo rats generally were more abundant on grazed plots, whereas Heermann's kangaroo rats and San Joaquin pocket mice were more abundant on controls, although the latter numbers were down from 2001. Giant kangaroo rat numbers are increasing. San Joaquin antelope squirrel numbers increased over 2001, but the difference in their abundance in controls and treatments continued to decrease in 2002. Ground invertebrates captured in pitfall traps remain low. In 2002 we initiated preliminary radio tagging studies of San Joaquin antelope squirrels and blunt-nosed leopard lizards. Antelope squirrel home ranges were significantly larger in treatment plots than in control (ungrazed) plots, while sample sizes of leopard lizards this year were too small to make any conclusions.

We will continue to gather information on the year-to-year variation in rainfall, plot condition, and relative abundance of plants and animals. We will also continue the radio tagging studies next year. With the numbers of most of the focus species continuing to increase and hopes of a predicted wet winter in 2003, we expect our 2003 fieldwork to result in some very interesting data in comparison with the last few dry years. As we have indicated in the past, the success of this study depends on time, patience, and resources. The continuation of the field research on the Lokern requires $65,000 per year, and this

[1]Authors of this unpublished report are: Germano, D. J., E. Cypher, S. Fitton, L. R. Saslaw, and G. B. Rathbun.

does not include the considerable in-kind support from cooperating agencies and organizations. We hope that all our cooperators and supporters will continue their devotion to the research.

Background

In 1995, the Bureau of Land Management (BLM) approached the US Geological Survey (then the National Biological Service) for assistance in developing a research project to help determine how livestock grazing on arid public lands in the southwestern San Joaquin Valley might be impacting several plant and vertebrate species that were listed by state and federal agencies as threatened or endangered. The Western Ecological Research Center (WERC) of the Biological Resources Division developed a research proposal to carry out the research in cooperation with several other agencies and organizations interested in the topic (see Cooperators Section below).

In 1997, a study site on the Lokern Natural Area in western Kern County was chosen and prepared for the research. This included fencing eight plots (Figure 1): four controls (each 62 acres or 29 hectares) each nested within four treatment pastures (one Section each or 640 acres or 259 hectares). Water was piped into each treatment plot for the cattle.

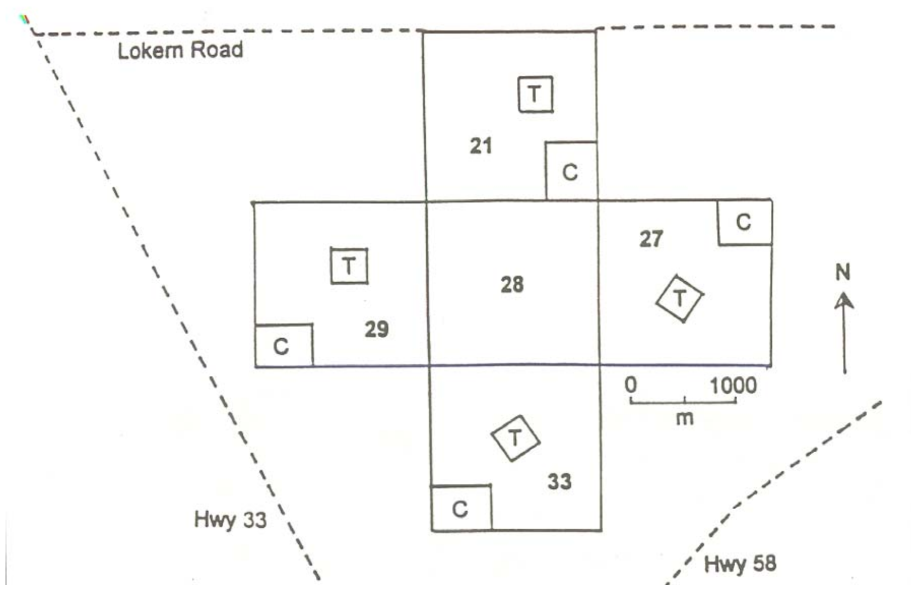


Figure 1. Lokern Study Area showing design of experimental and control plots.

Midway through the construction of cattle fencing in May 1997, an accidental wildfire burned through half of the study area. In order to reduce the confounding effect of this fire on the study design, the other half of the study area was intentionally burned in July

1997. Initial, baseline plant sampling was completed on the four treatment and four control plots before the burns in 1997, while baseline vertebrate sampling was completed on the eight plots after the burns in July and August 1997. A summary of these results, along with a copy of the research study plan, was included in the Annual Report for 1997 (http://www.werc.usgs.gov/sandiego/lokern/lokern.htm). Cattle were turned out onto the newly fenced treatment plots for the first time in February 1998. The yearly plot, vegetation, and animal sampling schemes were completed as planned in 1998, and the cattle were removed in July 1998, just prior to mammal trapping. In 1999, 2000, and 2001, a similar schedule was followed, although with progressively lower grazing intensity as conditions dried each successive year. No cattle were on the site in 2002 or 2003 as rainfall was well below average and forage was not available.

Results

Rainfall

We recorded only 109.1 mm (4.30 inches) and 117.9 mm (4.64 inches) total rainfall for the 2002/2003 rainfall year (until 30 June 2003). Rainfall at the Buttonwillow station in 2002/2003 was 144.8 mm (5.70 inches). Using 20% or more below average rainfall to define a dry year, we have now experienced 4 straight dry years (Fig. 2). This follows 8 years of near average or wet weather (and 1 dry). As a measure of how unusual is this length of dry years, for the past 113 years in Bakersfield (65 km east of the study area), only 32 years were dry (28.3 % of years) and 4 straight dry years happened only once (1953-1957). Five straight dry years never occurred.

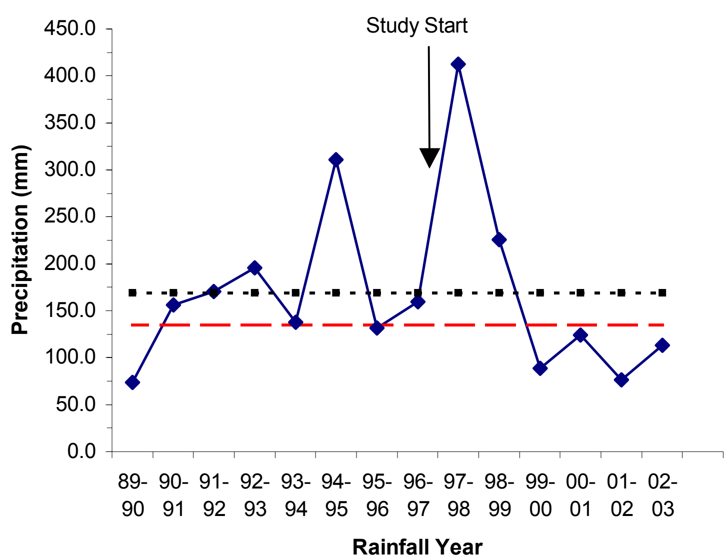


Figure 2. Rainfall on the Lokern Study Area since 1989. Data from 1989-1998 from the Buena Vista Water District in Buttonwillow, California. The dotted line is the 20-yr

mean of 169 mm. The dotted line is the mark of 20 % below long-term average (135 mm).

Grazing Effects on Plots

No cattle were on the plots in 2003 and, because of low rainfall, have not been on the treatment plots since mid-2001. In 2001, cattle were only on the plots a short time: 31 days (26 March – 25 April) on section 33, 23 days (25 April – 18 May) on section 27, 33 days (18 May – 19 June) on section 29, and 20 days (20 June – 9 July) on section 21. There remained significant differences, however, between treatment and control for three measures of summer herbaceous vegetation on the plots: RDM, height of vegetation, and cover (Table 2). For RDM, there was a significant difference among plots (ANOVA, $F_{7, 237} = 9.10$, $P < 0.001$). The difference is explained by treatment plots having less RDM than controls. Similarly for height, treatment plots had shorter vegetation than controls (ANOVA, $F_{7, 239} = 39.76$, $P < 0.001$). There were significant differences among plots for summer cover (ANOVA, $F_{7, 239} = 52.43$, $P < 0.001$), and all but one of the controls (27C) had more summer cover than the treatments (Table 2). All measures of herbaceous plant growth were dramatically lower than in past years.

Table 2. *Cattle stocking rates and vegetation characteristics of study plots in 2002. Average cover determined by percentage cover classes (100%, 95%, 75%, 50%, 25%, 0%).*

		Vegetation		
Plots	Stocking Rates (AUM*)	RDM (lbs/acre)	Average Height (cm)	Average Cover (%)
21C	0	1465	15.5	86.3
21T	0	157	4.0	17.6
27C	0	797	10.2	31.0
27T	0	98	0.8	1.5
29C	0	859	17.7	68.2
29T	0	151	3.8	10.1
33C	0	1104	19.5	88.3
33T	0	20	1.8	6.3

* 1 AUM = one cow weighing 1000 lbs for one month. Stocking rate is for the entire 2002 grazing season. Cow/calf pairs used equaled 1 AUM.

Vegetation Surveys

Personnel collecting data from March 19 to 25, 2002 were Dr. Ellen Cypher of the Endangered Species Recovery Program (ESRP) and John Moule and James Mann of the U.S. Bureau of Land Management (BLM). Funding for these personnel was provided by their sponsoring agencies. Data were collected earlier than in 2001 because the vegetation had reached peak growth by late March and was beginning to decline. Reproductive density (the total number of buds, flowers, and fruits per meter^2) and fecundity (number of flowers per plant) of Kern mallow (*Eremalche parryi* ssp. *kernensis*) were recorded on all 80 permanent sampling belts (20 m by 0.25 m). Cover and composition of vegetation were determined on all 32 permanent transects. Data were pooled for each study plot.

Only two Kern mallow plants were encountered in the sampling belts in 2002, both in the grazed area of Section 29. Each plant had a single flower. The grazed area of Section 29 has had the highest density of Kern mallow throughout the study period, including the baseline year of 1998. Thus, data from 2002 do not provide any insights into the effects of cattle grazing on Kern mallow.

Herbaceous cover was extremely low in 2002, and vegetation characteristics were extremely variable among the study plots, even those subject to the same grazing regime (Table 3). Overall, herbaceous cover was an order of magnitude lower than it had been in 2001 due to the very low rainfall during the growing season of 2002. Data on microbiotic crust cover were unreliable and thus are not presented. Shrub cover was twice as high in 2002 as it had been the previous year. Shrubs were virtually eliminated by the 1997 fire but have reseeded naturally into the study area and continue to increase in size. The number of species encountered on each permanent transect was only one-quarter of that observed in the previous year. Red brome (*Bromus madritensis* ssp. *rubens*) and red-stemmed filaree (*Erodium cicutarium*) were the dominant or co-dominant species on all plots in 2002 (Table 4), as they have been in previous years. However, the absolute cover of each was extremely low, with the overall cover of red brome and red-stemmed filaree averaging only 15% and 5%, respectively, of those observed during 2001.

Table 3. *Mean vegetation characteristics (standard deviation) over four transects on each Lokern study plot, Spring 2002.*

Study Plot/ Treatment	Herbaceous cover (%)	Shrub cover (%)	Number of species on belt
21C	15.8	2.3	5.8
	(2.9)	(1.3)	(1.7)
21T	13.8	0.3	6.8
	(9.2)	(0.5)	(2.2)
27C	10.8	0	3.5
	(13.6)		(2.4)
27T	0.3	0	3.0
	(0.5)		(3.4)
29C	3.0	2.3	2.0
	(4.1)	(2.6)	(0.8)
29T	2.0	0	5.0
	(2.2)		(1.6)
33C	1.3	0	2.0
	(1.9)		(0.8)
33T	0	0	0.3
			(0.5)
Overall	5.8	0.6	3.5
	(8.2)	(1.3)	(2.7)

Table 4. *Mean absolute percent cover of dominant species (standard deviation) over four transects on each Lokern study plot, Spring 2002.*

Study Plot/Treatment	*Bromus madritensis* ssp. *rubens*	*Erodium cicutarium*
21C	10.0	6.8
	(4.4)	(3.5)
21T	5.5	9.8
	(4.7)	(8.0)
27C	8.8	3.0
	(12.3)	(2.7)
27T	0	0.3
		(0.5)
29C	3.0	0
	(4.1)	
29T	0.5	1.5
	(0.6)	(1.7)
33C	0.8	0.5
	(1.0)	(1.0)

33T	0	0
Overall	3.6 (5.9)	2.7 (4.5)

Mammal Surveys

The total number of individual nocturnal small mammals captured this year continued the increasing yearly trend (Table X), as did San Joaquin antelope squirrels (*Ammospermophilus nelsoni*) (Table Y). Short-nosed kangaroo rats (*Dipodomys nitratoides brevinasus*) and Heermann's kangaroo rats (*Dipodomys heermanni*) contributed greatly to the total nocturnal mammals captured (Table Y), as in past years, but if it were not for the large jump in San Joaquin pocket mice (*Perognathus inornatus*) from 17 last year to 65 individuals this year (Table Z) the increasing overall trend would not be as strong. We suspect that the below average rainfall over the last four years (Fig.) may be starting to reduce the food supply (Fig. ___), which in turn may be causing the declining numbers of the larger Heermann's kangaroo rat, from 97 last year to 34 this year (Fig. C). Yearly captures of giant kangaroo rats (*Dipodomys ingens*) have varied from none to a high this year of seven (Table Z). The other small mammals have always been captured in small numbers sporadically across years. This year, however, we captured for the first time a California pocket mouse (*Chaetodipus californicus*) on the study area (Table Z).

Variability in captured small mammals between plots continued to be high (Tables Y & Z), but a trend may be developing with total numbers captured on control plots (pooled) becoming greater than on the pooled treatment plots (Fig. A). This trend is especially evident with the antelope squirrels (Fig. B) and Short-nosed kangaroo rats (Fig. D). We believe this shift reflects the similarity in the vegetation structure between all plots after four years of below average rainfall (Fig.) and low plant productivity, which has resulted in no cattle grazing on any of the treatments for the last two years.

Table X. Total individual nocturnal small mammals captured on the control (C) and treatment (T) plots by year.

	1997	1998	1999	2000	2001	2002	2003
21C	0	12	10	4	33	34	58
21T	0	3	22	3	22	51	46
27C	1	20	111	65	87	80	105
27T	2	3	78	51	61	76	48
29C	0	1	0	12	51	68	65
29T	0	1	38	20	62	57	84
33C	0	2	4	0	38	53	67
33T	0	1	8	26	83	69	41
Total	3	43	271	181	437	437	514

Table Y. Total individual San Joaquin Antelope Squirrels captured on the control (C) and treatment (T) plots by year.

	1997	1998	1999	2000	2001	2002	2003
21C	4	5	2	1	4	10	14
21T	9	2	5	4	5	7	12
27C	3	8	2	5	13	21	21
27T	4	2	15	17	38	31	20
29C	5	0	0	1	9	20	41
29T	1	2	6	0	10	10	27
33C	6	5	7	9	26	16	26
33T	5	9	23	19	20	12	17
Total	37	33	60	55	125	127	178

Table Z. Total nocturnal mammal species* captured on the control (C) and treatment (T) plots in 2003. All numbers are of individuals captured.

	DH	DN	DI	PI	CC	PM	OT	RM	MM	Total
21C	1	41	2	13	0	0	1	0	0	58
21T	0	33	2	10	0	0	1	0	0	46
27C	0	87	0	17	0	0	1	0	0	105
27T	0	36	0	11	1	0	0	0	0	48
29C	28	37	0	0	0	0	0	0	0	65
29T	4	76	0	4	0	0	0	0	0	84
33C	1	64	0	0	0	0	2	0	0	67
33T	0	28	3	10	0	0	0	0	0	41
Total	34	402	7	65	1	0	5	0	0	514

*

DH = *Dipodomys heermanni*, Heermann's Kangaroo Rat
DN = *Dipodomys nitratoides*, San Juaquin Kangroo Rat
DI = *Dipodomys ingens*, Giant Kangaroo Rat
PI = *Perognathus inornatus*, San Joaquin Pocket Mouse
CC = *Chaetodipus californicus*, California Pocket Mouse
PM = *Peromyscus maniculatus*, Deer Mouse
OT = *Onychomys torridus*, Souther Grasshopper Mouse
RM = *Reithrodontomys megalotus*, Western Harvest Mouse
MM = *Mus musculus*, House Mouse

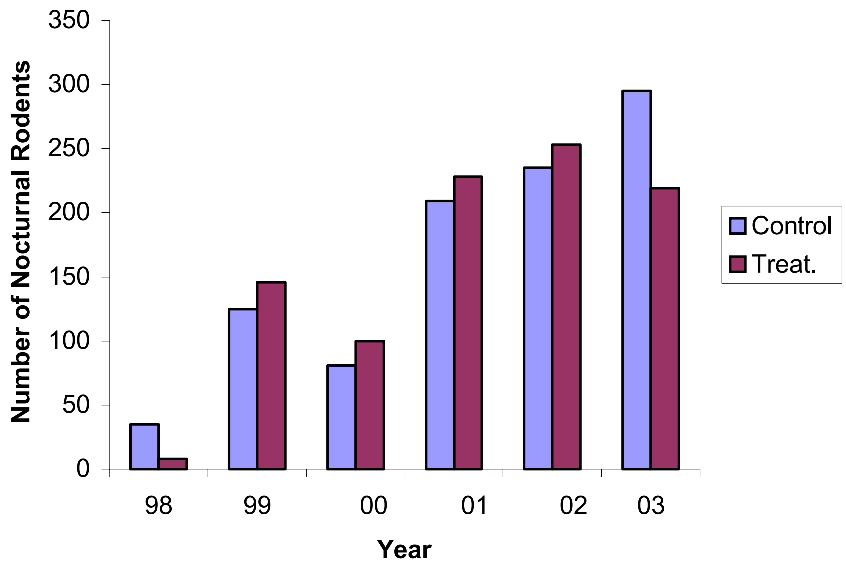


Fig. A. Total number of individual nocturnal rodents captured on the control and treatment plots on the Lokern study site from 1998 through 2003 (only 3 rodent were captured in 1997 – see Table X).

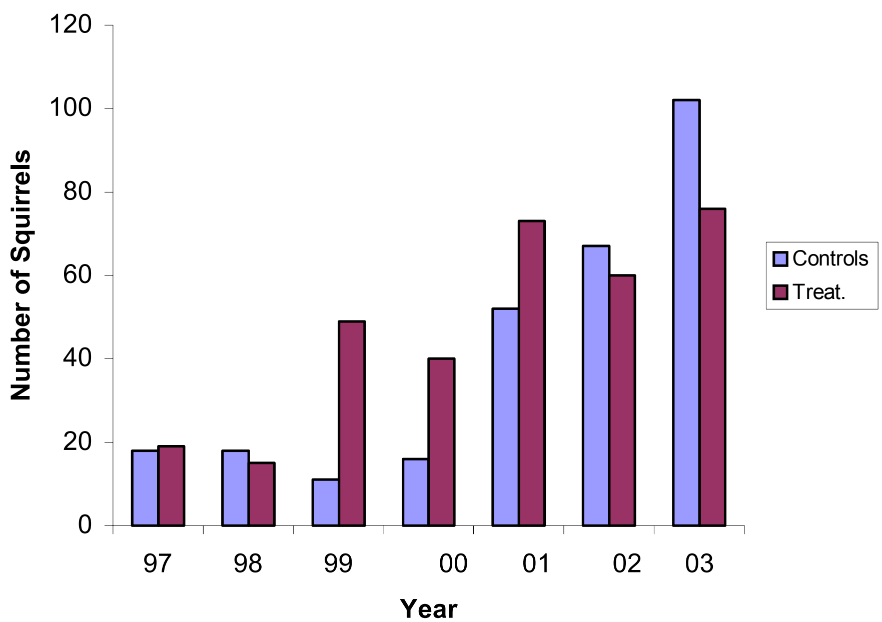


Fig. B. Total number of individual San Joaquin antelope squirrels captured on the control and treatment plots on the Lokern study site from 1997 through 2003.

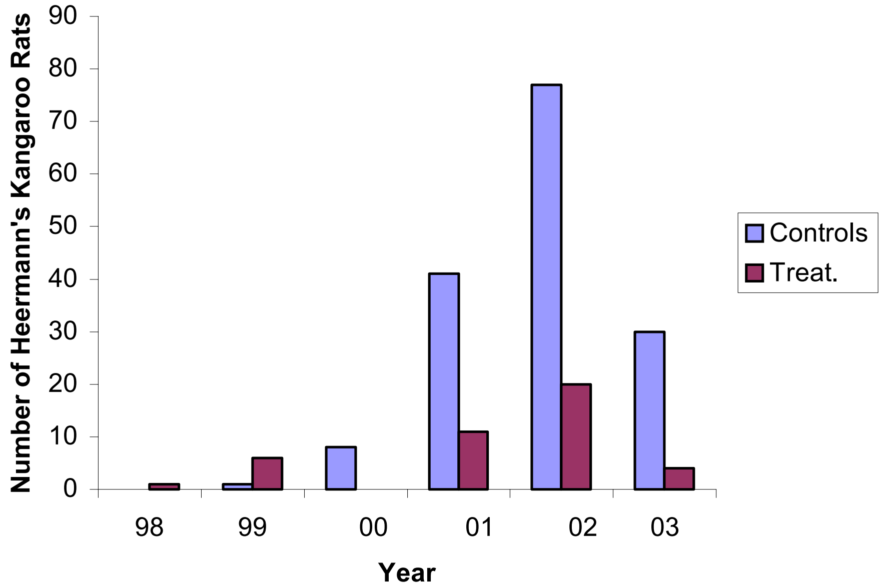


Fig. C. Total number of individual Heermann's kangaroo rats captured on the control and treatment plots on the Lokern study site during 1998 through 2003.

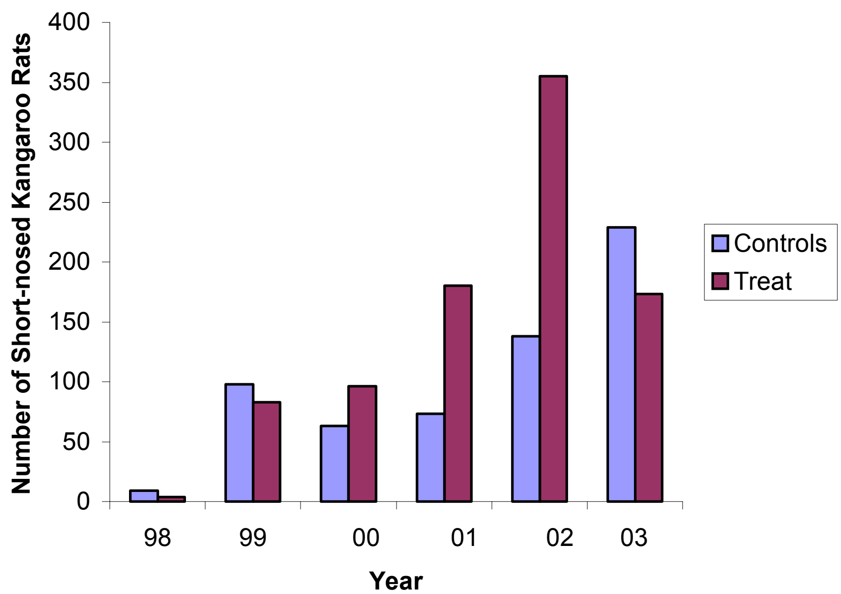


Fig. D. Total number of individual Short-nosed kangaroo rats captured on the control and treatment plots on the Lokern study site from 1998 through 2003.

Bird Surveys

Four species of birds were detected within the 100 m radius point counts in 2002 (Table 7). Sage sparrow (*Amphispiza belli*) numbers were a little higher this year than in 2001, but they only occurred on control plots. Good habitat for sage sparrows consists of saltbush shrubs, which were largely destroyed in the study area by the 1997 fire. Since then, this bird has been disappearing from the plots, most quickly in the grazed plots. Horned larks (*Eremophila alpestris*) were generally more numerous on grazed plots than the control plots. However, unlike last year, there were sightings within two of the control plots (Table 7). Western meadowlark (*Sturnella neglecta*) numbers dropped dramatically compared to 2001. None were detected on grazed plots and the average point count value for the control plots was less than half of the previous lowest average.

Table 7. *Average point-count values for bird species at the Lokern study site in 2002*.

Species[1]	21C	21T	27C	27T	29C	29T	33C	33T
HOLA	1.75	1.25	0.75	1.5	0	1	0	2
MODO	0.25	0	0	0	0	0	0.25	0
SAGSP	0.25	0	0.25	0	1.25	0	0	0
WEME	0	0	0	0	0.5	0	0.5	0

[1]HOLA, Horned Lark; MODO, Mourning Dove; SAGSP, Sage Sparrow; WEME, Western Meadowlark.

Birds detected during point counts mainly are breeding in the study area. Birds have also been counted that have been detected flying over point count plots, but could not be considered to be within point count detection area. This category shows species that are making some use of the study area, but may not breed on site. This count shows that a few more species make use of the area than are found on point count plots, especially common ravens (*Corvus corax*; Table 8).

We also censused birds by recording species found within a 300 X 300 m area beyond the point count plots. This method should assess larger species of birds because the area of detection is larger than the other two census methods. However, these larger species do not necessarily breed on site, such as the common raven (Table 9). Of special interest is the Le Conte's thrasher (*Toxostoma lecontei*), a species of special concern, which has not been sighted since 1997. It inhabits shrubs, such as saltbush, and the fire in 1997 seems to have eliminated (at least temporarily) the larger plants of this species from the study area.

Table 8. *Total counts of birds observed flying overhead during point-counts in 2002.*

Species	Control	Treatment
Cliff swallow	1	1
Common raven	7	5
Horned lark	6	1
Mourning dove	0	2
Unknown blackbird species	4	0
Western meadowlark	3	0

Table 9. *Number of times a species was detected in 2002 within a 300 X 300 m area (out of a possible 16 per controls or treatments), but not in point count plots.*

Species	Controls	Treatments
Burrowing Owl	2	3
Cliff Swallow*	2	1
Common Raven	5	7
Horned Lark	0	2
House Finch	0	1
Loggerhead Shrike	2	1
Mourning Dove	4	0
Northern Harrier	0	1

Red-tailed Hawk	1	0
Sage Sparrow	4	0
Western Kingbird	1	0
Western Meadowlark	5	1
White-throated Swift	1	0

*Unlikely to breed in area

Lizard Surveys

Blunt-nosed leopard lizards (*Gambelia sila*) are still not abundant on the study area, but more sightings were made during the May-June 2002 censuses than any other year except 1997 (before the fire). Leopard lizards were found on treatment plots of both section 27 and 33 (Table 10). Additionally, 20 blunt-nosed leopard lizards were caught and marked on sections 27 and 33, 11 of which were radio-collared to determine home range size (see section on Radio Tagging Studies). Of the remaining 9 lizards, all were adults found either while locating radio-collared lizards or while driving to and from the study site. No blunt-nosed leopard lizards were found on control plots, nor were any seen anywhere in sections 21 or 29. No hatchling lizards were seen in August 2002 during rodent trapping, as was the case last year.

The only other lizards that we have found on the study area, side-blotched lizards (*Uta stansburiana*) and western whiptail lizards (*Cnemidophorus tigris*), were more abundantly this year than in past years (Table 10). However, unlike past years, both side-blotched lizards and western whiptail lizards were similarly abundant on control and treatment plots.

Table 10. *Total number of sightings of blunt-nosed leopard lizards, side-blotched lizards, and western whiptail lizards on the study plots during a non-consecutive 10-day survey in May and June 2002.*

Plot	Blunt-nosed Leopard Lizard	Side-blotched Lizard	Western Whiptails
21C	0	149	42
21T	0	189	30
27C	0	183	69

27T	12	147	70
29C	0	93	75
29T	0	105	86
33C	0	13	1
33T	4	44	20
Totals	16	923	393

Invertebrate Studies

In 2002, mean numbers of grasshoppers counted per day during censuses for lizards were similar to the numbers counted in 2000, but decreased from numbers counted in previous years (Table 11). Differences in abundances across plots were not related to the grazing treatment of the plot.

Other terrestrial invertebrates were sampled with arrays of ten pitfalls on each of the eight plots, as in the past six years (see Annual Report for 1997). These traps were monitored during the same six days that mammals were trapped in July/August, also as done before. In 2002, the average number of invertebrates found per day in pitfall traps was less than 2001, but similar to numbers in 2000 (Table 12). No differences in invertebrate numbers were found between controls and treatments.

Table 11. *Mean number (standard deviation) of grasshoppers counted per day on plots during 10-day surveys for blunt-nosed leopard lizards.*

	Average Number Counted Per Day					
Plot	1997	1998	1999	2000	2001	2002
21C	5.2 (4.85)	611.2 (563.1)	69.4 (68.33)	18.2 (10.50)	156.0 (66.16)	58.9 (28.69)
21T	6.4 (6.62)	654.4 (437.9)	77.4 (59.66)	38.6 (8.76)	203.1 (110.1)	42.6 (20.21)
27C	4.3 (3.40)	139.6 (50.35)	54.1 (53.98)	23.2 (4.39)	521.3 (129.0)	29.0 (10.11)
27T	4.9 (4.70)	192.0 (64.96)	211.2 (189.5)	33.1 (5.17)	239.7 (52.08)	26.3 (6.83)
29C	10.6 (5.15)	136.7 (130.9)	329.5 (248.2)	19.2 (5.94)	968.8 (469.0)	24.5 (9.26)

29T	11.9 (7.84)	473.8 (475.8)	39.1 (15.44)	41.8 (8.64)	466.6 (133.9)	37.0 (16.51)
33C	11.2 (12.8)	55.3 (53.11)	27.1 (12.21)	5.6 (4.01)	139.9 (85.75)	15.8 (6.86)
33T	12.7 (11.1)	131.0 (114.6)	65.6 (36.28)	16.5 (9.22)	166.3 (64.00)	14.8 (9.27)

Table 12. *Average number of invertebrates/pitfall/day on study plots by year. Numbers in parentheses are averages excluding ants.*

Plots	1997	1998	1999	2000	2001	2002
21C	3.9 (3.3)	11.1 (6.1)	1.3	1.5	2.4 (1.7)	3.3 (1.2)
21T	4.2 (2.7)	15.0 (11.7)	4.7	1.4	6.7 (0.9)	3.1 (1.0)
27C	4.2 (3.0)	24.7 (4.2)	2.9	1.4	1.6 (1.3)	4.8 (1.4)
27T	3.9 (2.9)	9.4 (2.2)	1.3	0.8	2.7 (0.5)	2.5 (2.2)
29C	5.0 (3.5)	5.8 (3.7)	1.5	2.7	4.5 (2.0)	3.3 (1.6)
29T	12.9 (5.1)	7.4 (3.9)	1.8	1.6	1.3 (1.0)	2.4 (1.0)
33C	4.5 (4.3)	5.8 (5.0)	1.4	3.6	3.2 (1.9)	12.1 (2.3)
33T	4.4 (3.0)	21.8 (9.5)	1.3	2.0	4.2 (1.0)	5.3 (1.5)

Rodents and lizards are also captured in the pit-fall traps on the study site. Compared to past years, few rodents were found in pit-fall taps in 2002. One San Joaquin pocket mouse and 2 southern grasshopper mice were caught in 480 pit-fall days. One hundred and twenty-two side-blotched lizards and 17 western whiptails were caught in pitfall traps, and there was no difference in abundance between treatment and control plots.

Multiyear Results

This study has been underway for 6 years, but only in the past 3 years have we started to catch numerous animals on our plots. When we started in 1997, we caught or observed almost no animals. Kern mallow, however, was relatively abundant in the early years. Dry conditions in the past three years (Fig. 4) have led to a decrease of herbaceous plant biomass across all plots (Fig. 5), a decrease in herbaceous cover overall (Fig. 6), and a marked decline in the abundance of Kern mallow (Fig. 7). This aridity and decreasing biomass of herbaceous plants has been matched by increasing numbers of rodents and lizards. The decrease in residual dry matter and herbaceous cover has been greatest in grazed pastures but has been pronounced in the control pastures as well, even without cattle grazing (Fig. 5, Fig. 6). Unfortunately, these data tell us little about how cattle grazing has affected animal species abundances. Although we were beginning to see a trend of greater numbers of rodents and lizards in treatment plots, the trend did not hold as conditions continued to dry and vegetation declined in the controls. In the past 2 years, the control plots have become only marginally different than the treatment plots in terms of plant cover. Indeed, the control plots now have many areas devoid of vegetation. Also, the trails made by researchers conducting censuses have become pronounced on the controls and are serving as habitat corridors for animals. We suspect that if we have average to above-average rain in the next year or two the control plots will once again become thickly vegetated with grass and herbs and act as a counterpoint to the grazed plots. While we wait for a wet winter, we have analyzed our data to date to see if we can detect a relationship between species and the decrease in herbaceous plant cover across the Lokern.

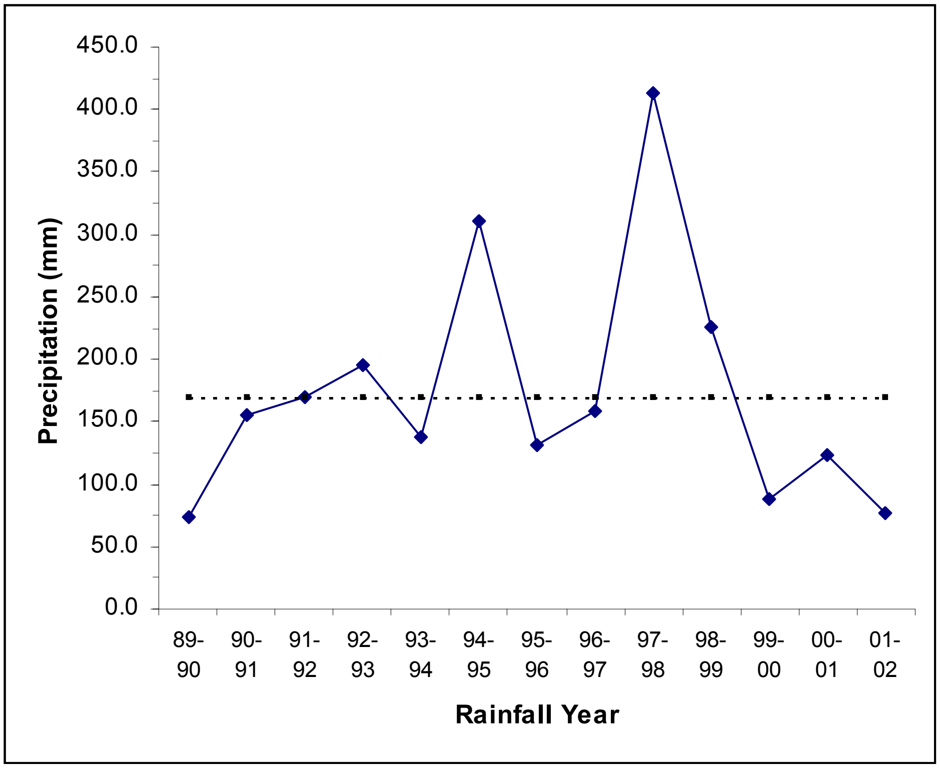


Figure 4. Rainfall on the Lokern study area in the past 13 years. Dashed line represents the long-term average (169 mm) taken from the Buttonwillow Water Storage District gauges.

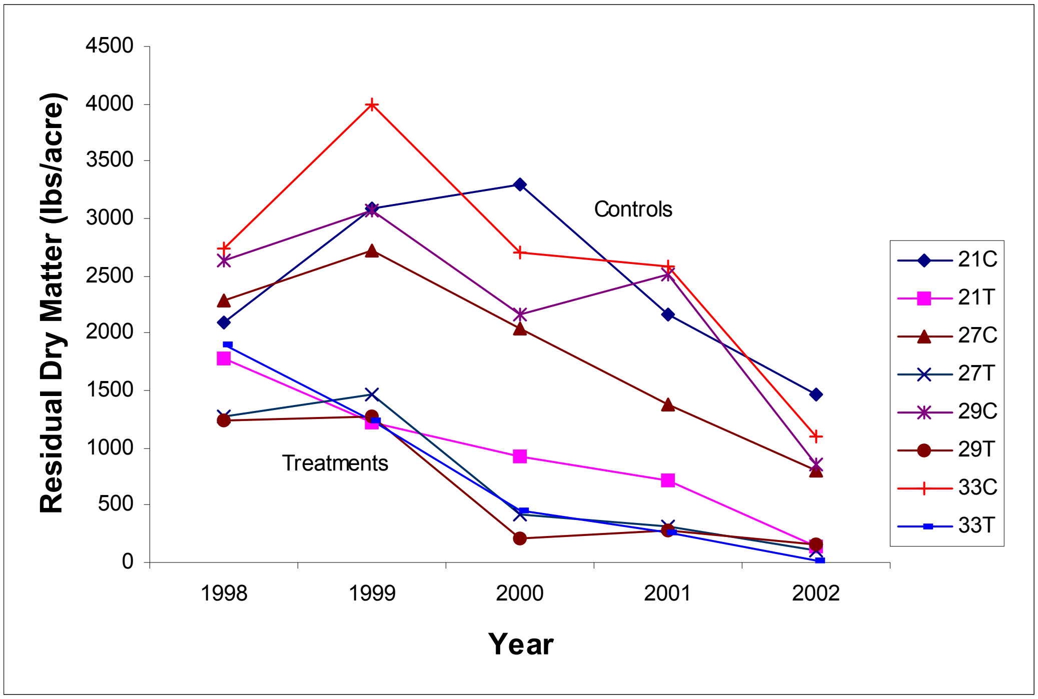


Figure 5. Amount of residual dry matter (a measure of herbaceous plant biomass production) measured each summer on control and treatment plots on the Lokern study area.

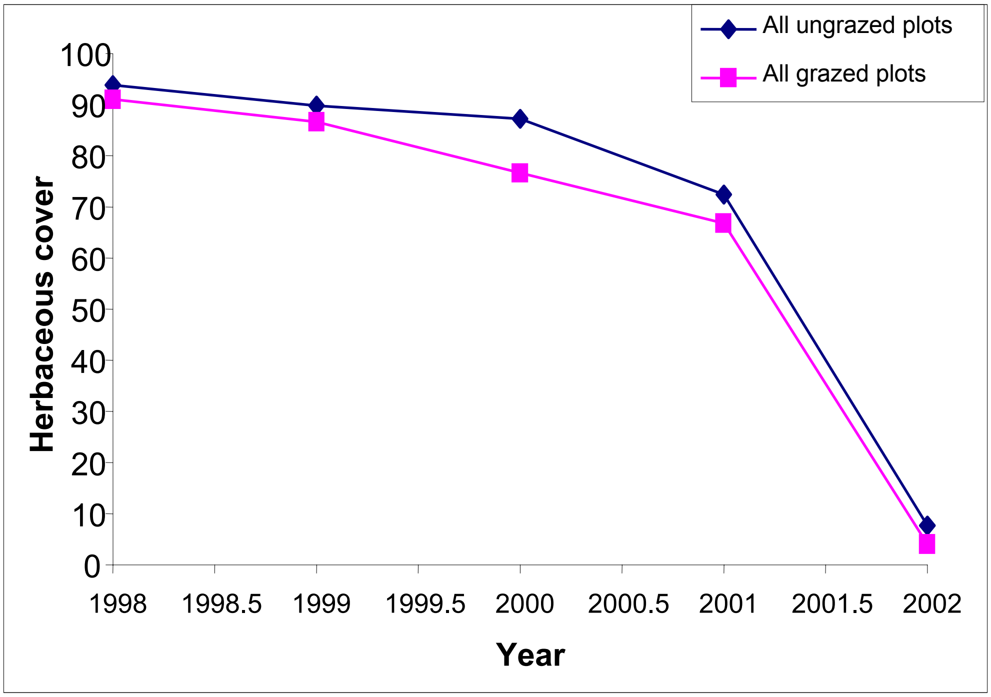
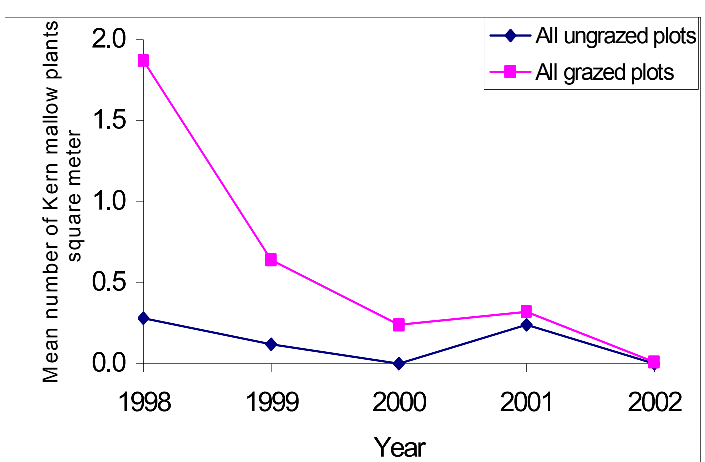
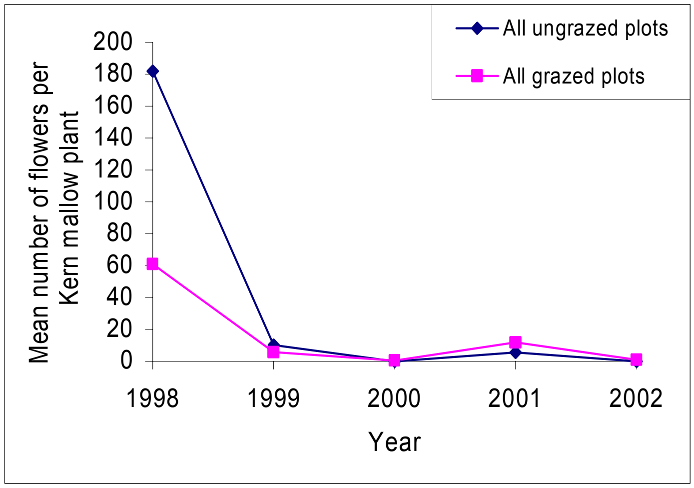


Figure 6. Herbaceous cover on vegetation transects in the Lokern study area.





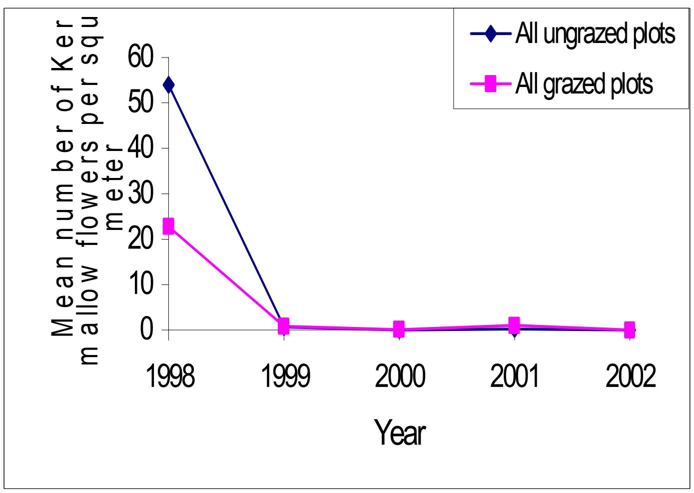


Figure 7. Abundance of Kern mallow at the Lokern study area each year: in terms of plant density (top), fecundity (center), and reproductive density (bottom). Grazing had not yet begun at the time of data collection in 1998.

Kern Mallow

Over the past 5 years, Kern mallow reproductive density has not shown any relationship to the amount of residual dry matter (Fig. 8) nor to herbaceous plant cover (Fig. 9). Instead, reproductive density of Kern mallow was significantly correlated with rainfall (Fig. 10), primarily due to the high flower production in 1998, which occurred in a growing season of record high rainfall.

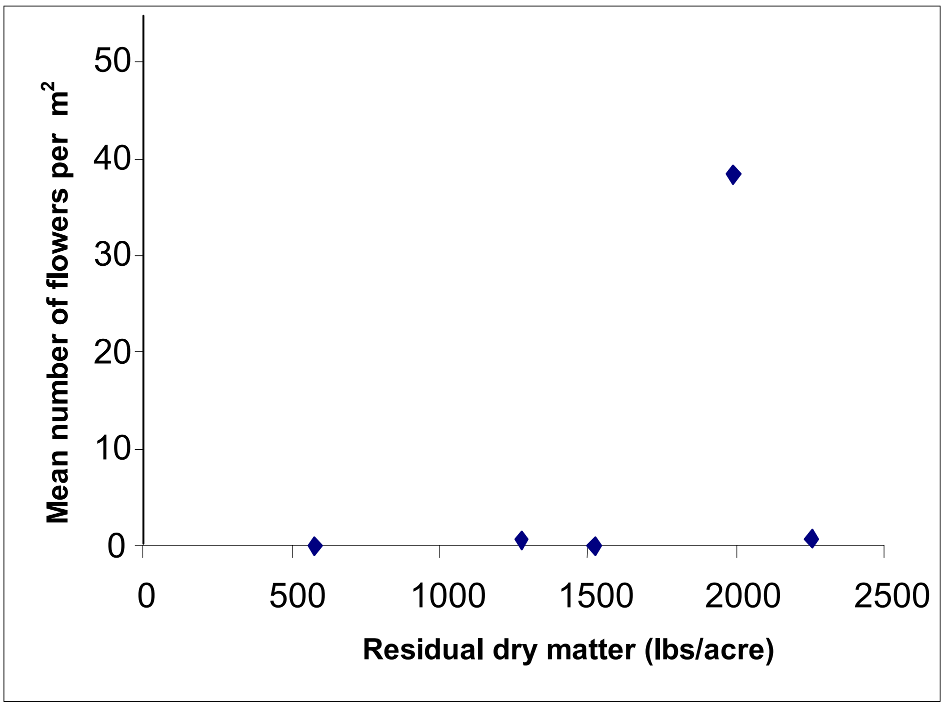


Figure 8. Kern mallow reproductive density relative to residual dry matter in the Lokern study area, 1998 through 2002. Correlation is not significant (r = 0.083, *P* = 0.611).

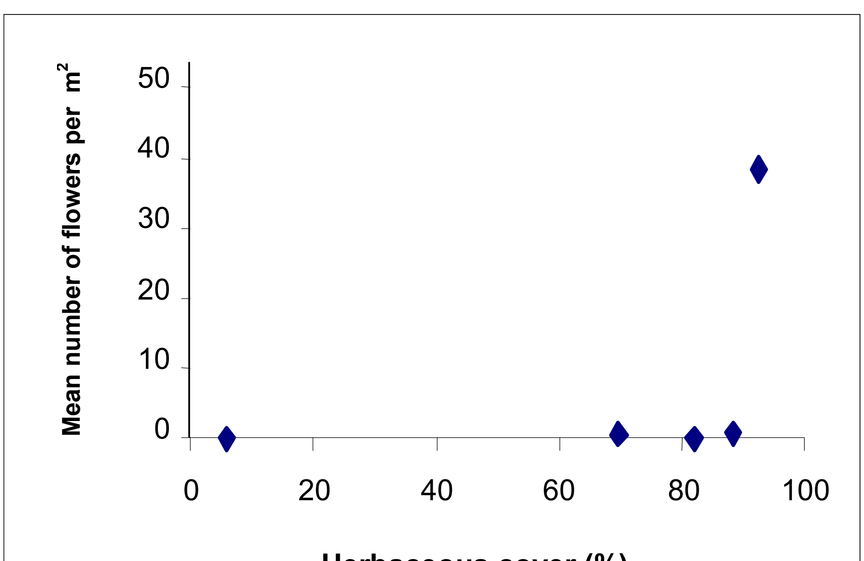


Figure 9. Kern mallow reproductive density relative to herbaceous cover in the Lokern study area, 1998 through 2002. Correlation is not significant (r = 0.400, $P = 0.509$).

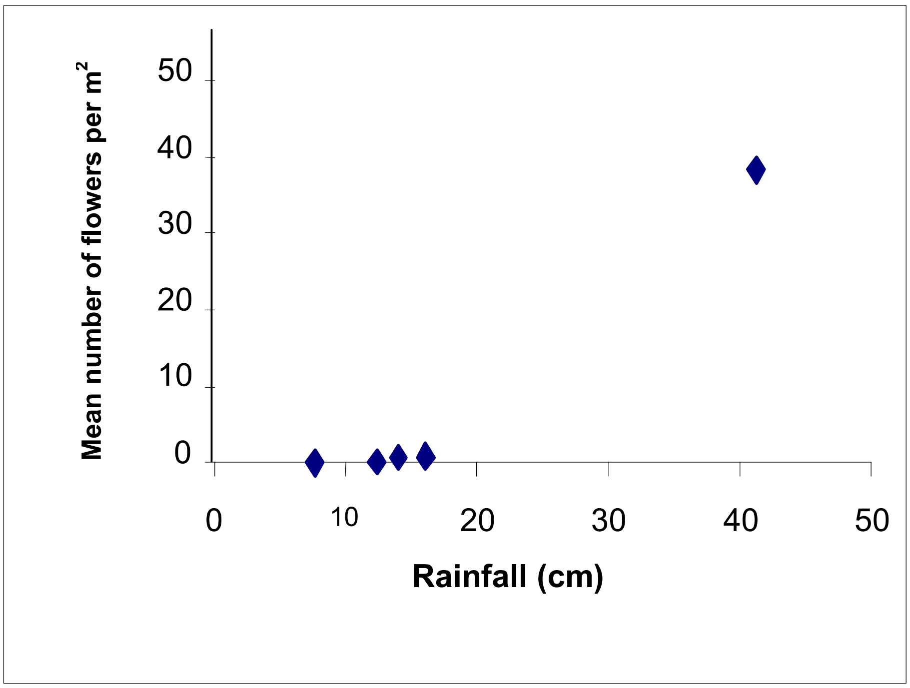


Figure 10. Kern mallow reproductive density relative to rainfall in the Lokern study area, 1998 through 2002. Correlation is highly significant (r = 0.976, $P = 0.006$).

Nocturnal Rodents

The numbers of nocturnal rodents have steadily increased since 1997 (Fig. 11). Most of this increase is due to short-nosed kangaroo rats (Fig. 12) and Heermann's kangaroo rats (Fig. 13). Total numbers of captures of all nocturnal rodents (Fig. 14), short-nosed kangaroo rats (Fig. 15), and Heermann's kangaroo rats (Fig. 16) are inversely correlated with herbaceous residual dry matter.

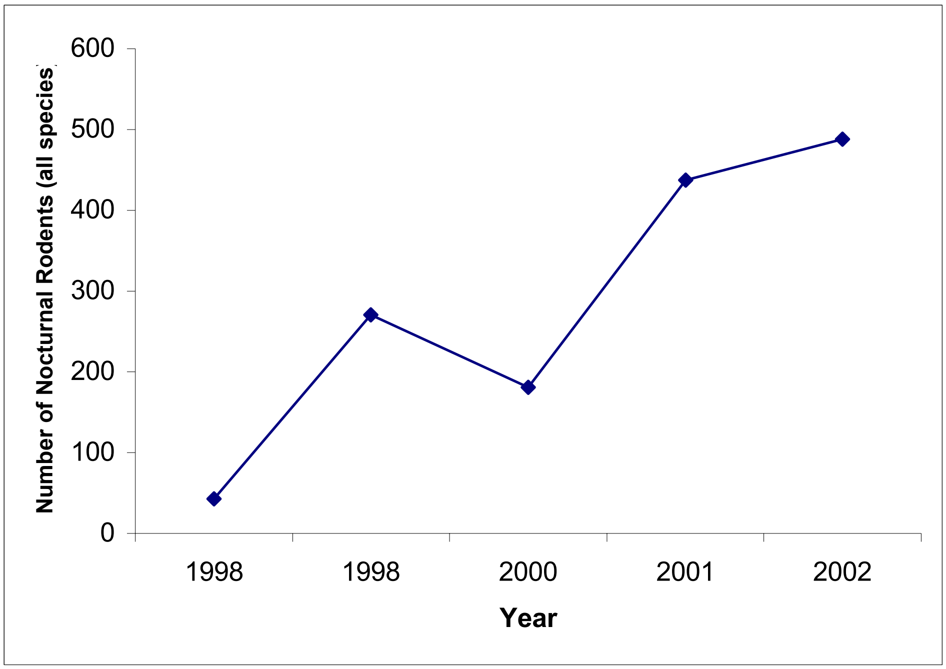


Figure 11. Total number of nocturnal rodent individuals captured each year at the Lokern study area.

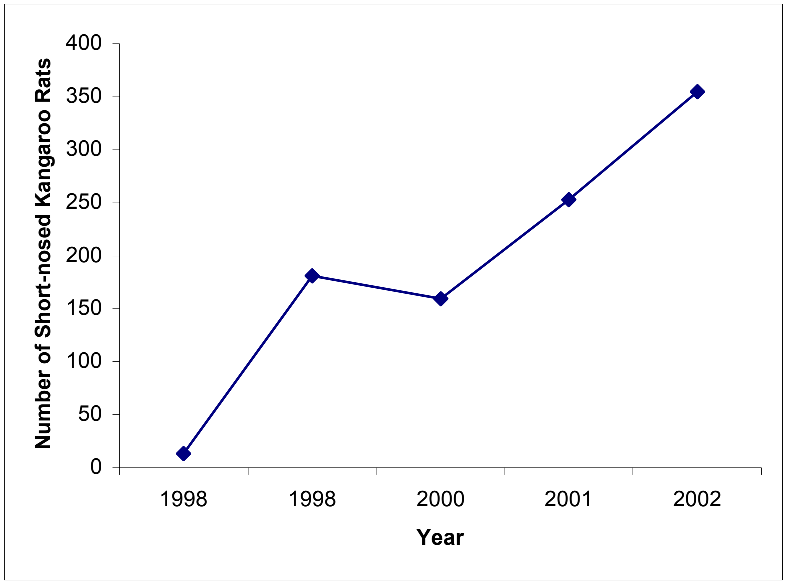


Figure 12. Total number of short-nosed kangaroo rat individuals captured each year at the Lokern study area.

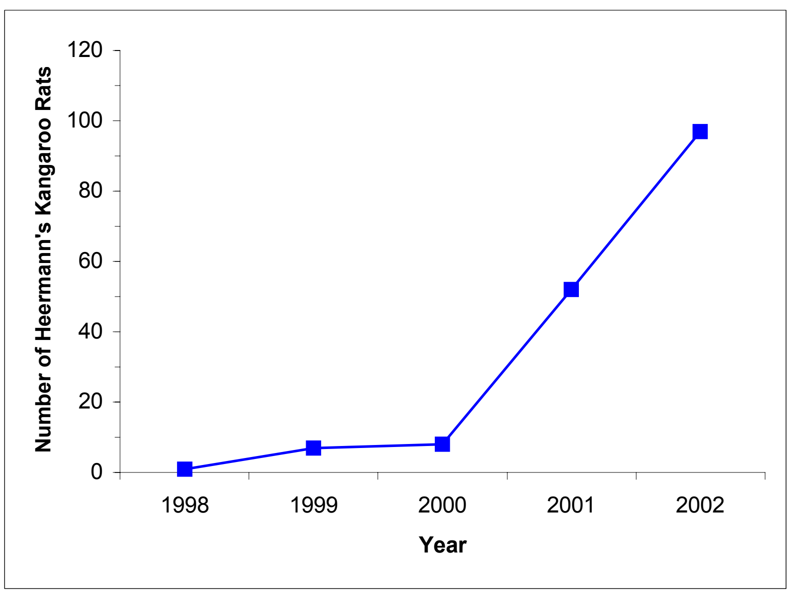


Figure 13. Total number of Heermann's kangaroo rat individualss captured each year at the Lokern study area.

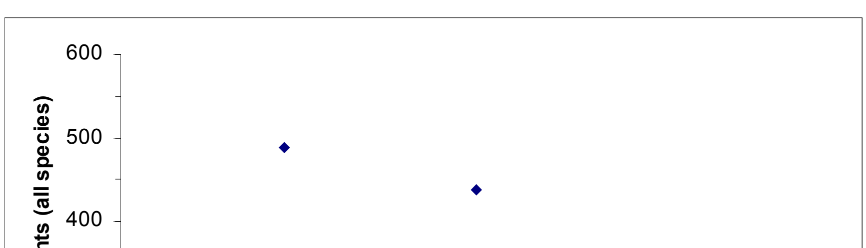


Figure 14. Inverse correlation between the number of nocturnal rodent individuals caught on Lokern study plots and residual dry matter, a measure of herbaceous plant biomass production.

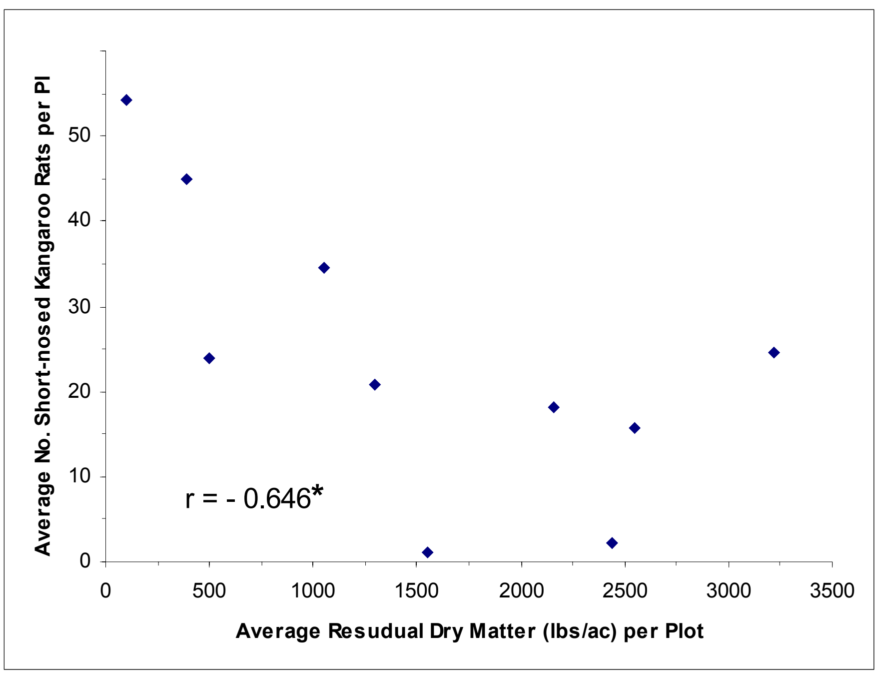


Figure 15. Significant inverse correlation between the average number of short-nosed kangaroo rats caught on Lokern study area treatment and control plots and residual dry matter, a measure of herbaceous plant biomass production.

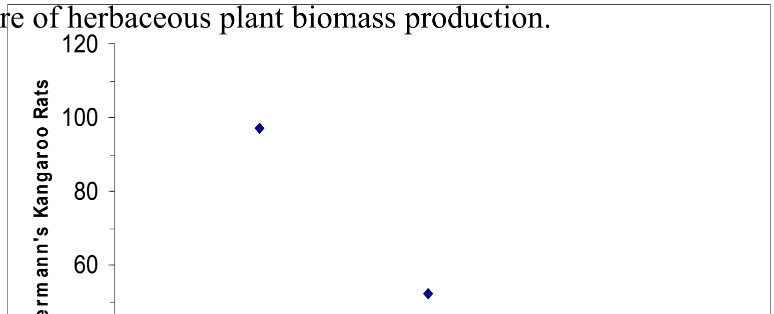


Figure 16. Significant inverse correlation between number of Heermann's kangaroo rats caught on Lokern study area plots and residual dry matter, a measure of herbaceous plant biomass production.

San Joaquin Antelope Squirrels

Numbers of San Joaquin antelope squirrels have steadily increased since the study began in 1997 (Figure 17). Similar to the relationship seen for nocturnal rodents, the increase in numbers of squirrels has occurred as rainfall and residual dry matter have decreased (Fig. 18).

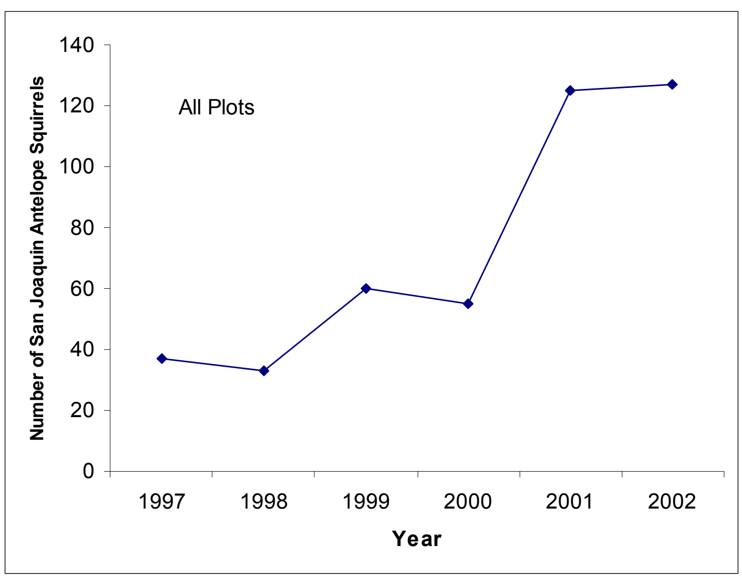


Figure 17. Total numbers of San Joaquin antelope squirrel individuals captured each year at the Lokern study area.

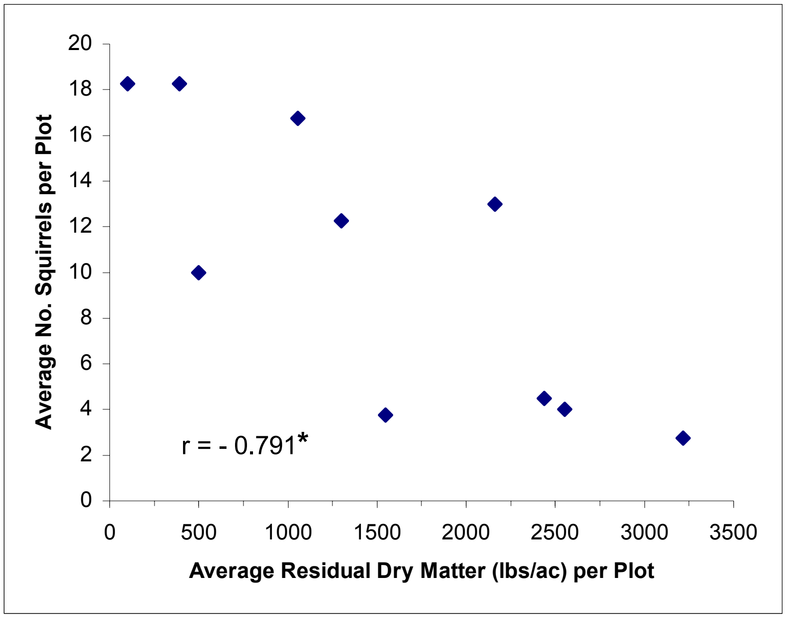


Figure 18. Significant inverse correlation between the average number of San Joaquin antelope squirrel individuals caught on Lokern study area treatment and control plots and residual dry matter, a measure of herbaceous plant biomass production.

Birds

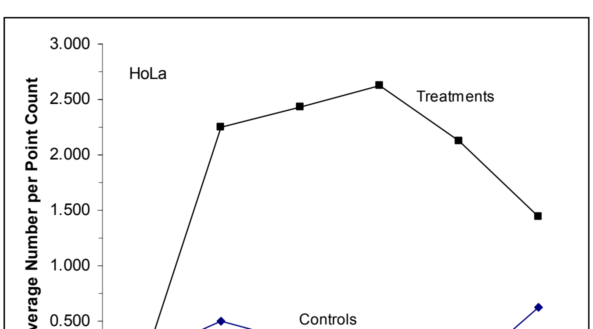
Only four species have shown up regularly on the plots at the Lokern study area: mourning doves, horned larks, western meadowlarks, and sage sparrows (Table 13). Mourning doves have been found only on control plots since 1997. For the three passerine species, horned larks were more abundant on treatment plots, western meadowlarks were only marginally more abundant on control plots, and sage sparrows were equally sighted on control and treatment plots, but have steadily declined in numbers since the study started in 1997 (Figure 19).

Table 13. *Average (standard deviation) point count values for birds by year and for control plots (C), and treatment plots (T).*

	1997		1998		1999		2000		2001		2002	
Species[1]	C	T	C	T	C	T	C	T	C	T	C	T
BRBL	0	0	0.06 (0.13)	0	0	0	0	0	0	0	0	0
BUOW	0	0	0	0	0.13 (0.25)	0	0	0	0	0	0	0
CORA	0	0	0	0.06 (0.13)	0	0	0	0	0	0	0	0
HOLA	0.19 (0.24)	0.06 (0.13)	0.5 (0.68)	2.25 (0.87)	0.31 (0.47)	2.44 (0.94)	0.38 (0.48)	2.63 (0.25)	0	2.13 (1.03)	0.6 (0.83)	1.4 (0.43)
LOSH	0	0	0	0	0.06 (0.13)	0	0	0	0	0	0	0
MODO	0.06 (0.13)	0.06 (0.13)	0.25 (0.35)	0	0.13 (0.14)	0	0.81 (0.56)	0	0.25 (0.29)	0	0.13 (0.14)	0
RWBL	0	0	0.5 (0.58)	0	0	0	0	0	0.06 (0.13)	0	0	0
SAGSP	2.38 (1.51)	2.13 (1.16)	1.5 (1.24)	1.69 (1.42)	0.94 (0.80)	0.63 (0.78)	0.5 (0.46)	0	0.06 (0.13)	0	0.44 (0.55)	0
SAVSP*	0	0	0.63 (0.32)	0.19 (0.24)	1.25 (1.31)	1.88 (2.15)	0	0	0	0	0	0
TRBL*	0	0	0.06 (0.13)	0	0	0	0	0	0	0	0	0
WCSP*	0	0	0.94 (1.09)	0.06 (0.13)	0	0	0	0	0	0	0	0
WEME	0.69 (0.31)	1.06 (0.55)	1.31 (0.85)	0.85 (0.72)	2.56 (0.52)	2.19 (0.55)	1.38 (0.52)	0.25 (0.25)	1.25 (0.35)	0.06 (0.13)	0.25 (0.29)	0

* Breeding unlikely.

[1] BRBL, Brewer's Blackbird; BUOW, Burrowing Owl; CORA, Common Raven; HOLA, Horned Lark; LOSH, Loggerhead Shrike; MODO, Mourning Dove; RWBL, Red-winged Blackbird; SAGSP, Sage Sparrow; TRBL, Tri-colored Blackbird; WCSP, White-crowned Sparrow; WEME, Western Meadowlark.



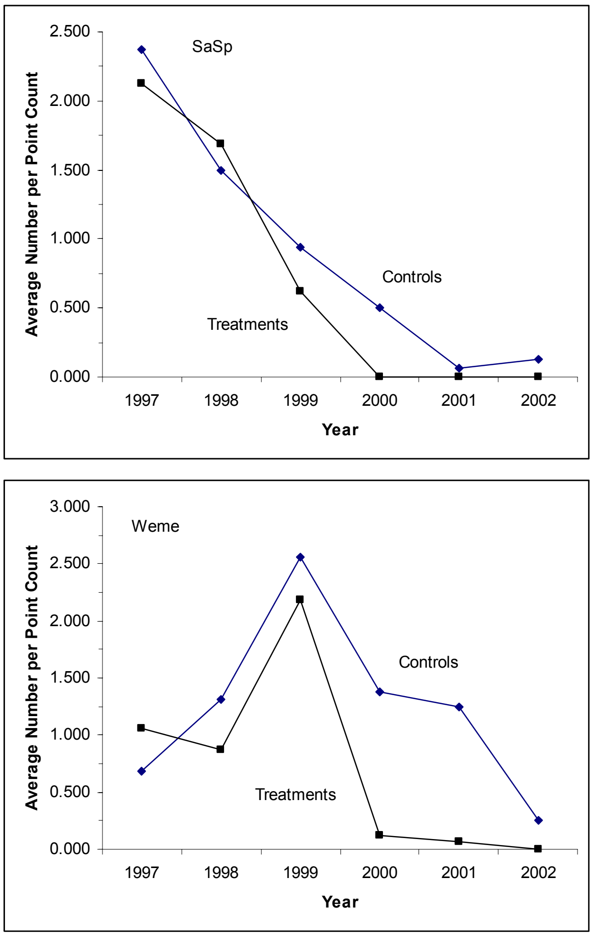


Figure 19. Average number of horned larks (HoLa), sage sparrows (SaSp), and western meadowlarks (WeMe) counted during point-count censuses on the Lokern study area 1997-2002.

Lizards

Between 1997 and 1999, only 2 of 34 sightings of blunt-nosed leopard lizards occurred in control plots, both in 21C (Table 14). Since 1999, no leopard lizards have been seen in control or treatment plots of section 21. Leopard lizards have been seen more regularly on the other treatment plots. In contrast, sightings of side-blotched lizards and western whiptail lizards have steadily increased each year (Table 15, Fig. 20, 21). Both side-blotched and western whiptail lizards are significantly inversely correlated with residual dry matter (Fig. 22, 23).

Table 14. *Total number of sightings of adult blunt-nosed leopard lizards during a non-consecutive 10-day survey in May and June each year on the Lokern study plots*.

Plot	1997	1998	1999	2000	2001	2002
21C	4	1	1	0	0	0
21T	2	0	0	0	0	0
27C	1	0	0	0	0	0
27T	3	0	2	6	1*	12
29C	3	0	0	0	0	0
29T	0	2	1	2	0	0
33C	0	0	0	0	0	0
33T	1	0	1	0	1	4
Totals	14	3	5	8	2	16

* 15 individual hatchlings and juveniles were found on this plot in August and September.

Table 15. *Total number of sightings of side-blotched lizards and western whiptail lizards on the Lokern study plots during a 10-day survey in May and June each year.*

	Side-blotched Lizards						Western Whiptails					
Plot	1997	1998	1999	2000	2001	2002	1997	1998	1999	2000	2001	2002
21C	3	2	0	8	18	149	1	7	0	1	7	42
21T	5	2	1	5	72	189	1	10	7	3	1	30
27C	5	2	5	7	33	183	1	4	5	5	11	69
27T	3	0	11	21	170	147	5	16	14	33	73	70
29C	2	0	1	3	35	93	2	1	7	5	42	75
29T	3	2	10	15	33	105	2	2	4	34	37	86
33C	1	0	0	0	3	13	0	1	0	0	0	1
33T	5	0	0	2	21	44	1	0	1	1	13	20
Totals	25	9	28	61	385	923	13	41	38	82	184	393

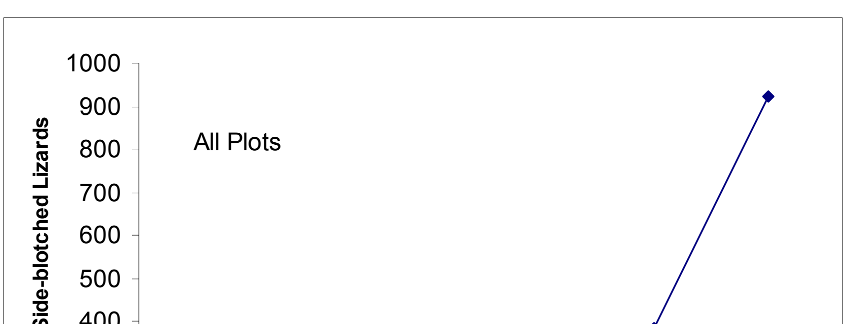


Figure 20. Total numbers of sightings of side-blotched lizards each year at the Lokern study area.

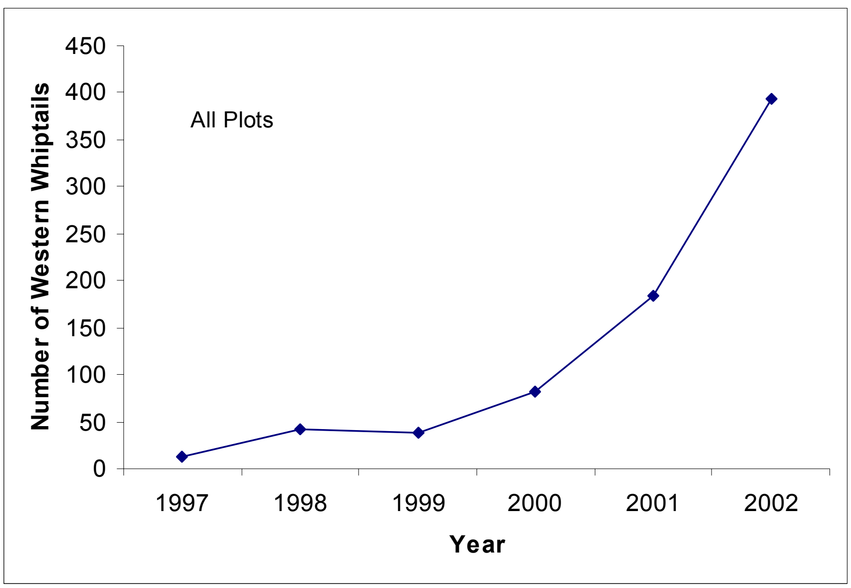


Figure 21. Total numbers of sightings of western whiptail lizards each year at the Lokern study area.

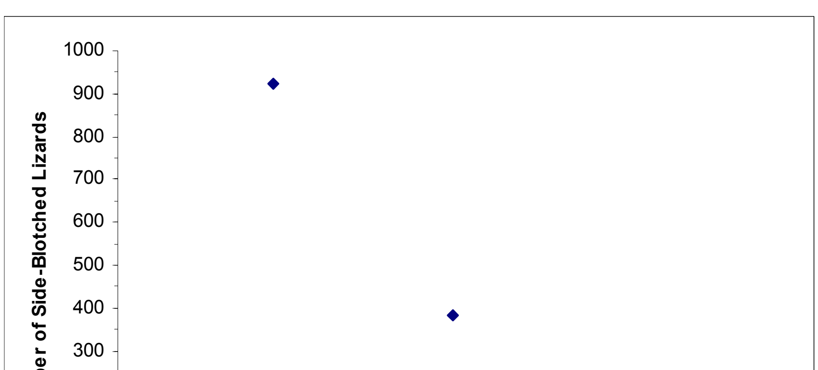


Figure 22. Significant inverse correlation between number of sightings of side-blotched lizards on Lokern study area plots and residual dry matter, a measure of herbaceous plant biomass production.

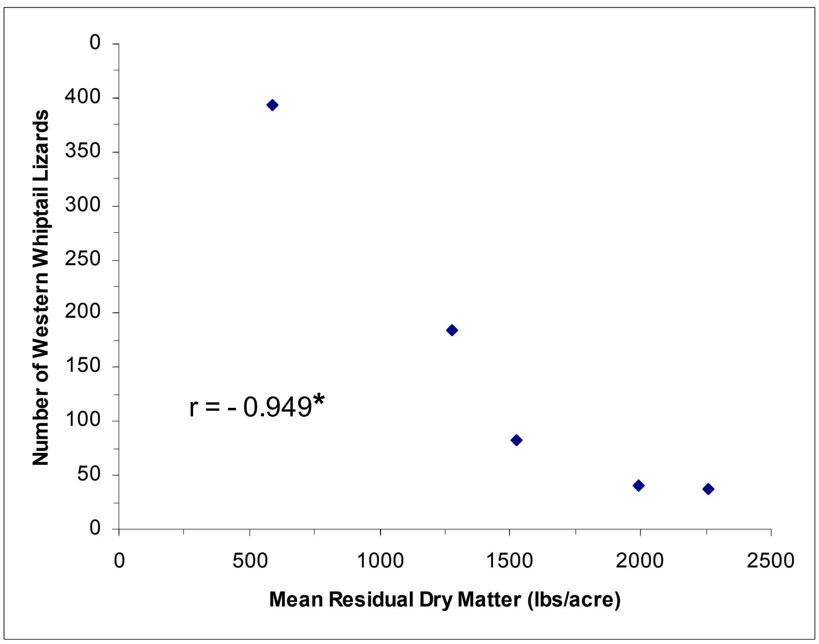


Figure 23. Significant inverse correlation between number of sightings of western whiptail lizards on Lokern study area plots and residual dry matter, a measure of herbaceous plant biomass production.

Radio Tagging Studies

We have been censusing San Joaquin antelope squirrels and blunt-nosed leopard lizards, both focus species, on the Lokern study area since 1997. Numbers of antelope squirrels have steadily increased, with generally greater numbers on the treatment (grazed) plots compared to the control (ungrazed) areas until recently (see Multiyear Results section).

These results suggest that we are indeed getting a grazing effect in terms of antelope squirrel numbers. Numbers of blunt-nosed leopard lizards have remained low, but they have increased markedly in the past two years (see Multiyear Results section). We have hypothesized that one mechanism for this difference is the difficulty that these small cursorial mammals may have in moving through dense (ungrazed) grass. A correlate of this would be the use of space, with dense grass inhibiting the squirrels from using large areas. One measure of the effect of dense grass would be to determine if there are any differences in the sizes of home ranges of squirrels on treatment and control areas. Similarly, leopard lizards would probably also have smaller home ranges on the control areas, where exotic annual grasses are thicker.

We radio-tracked antelope squirrels on the Lokern study site with the objective of determining whether home range sizes differed between the control and treatment plots. Unfortunately, the numbers of leopard lizards on the study area continues to be very low, thus making it difficult to measure the hypothesized effects of dense grass. However, we wanted to develop radio-tracking methods on the lizards, so we did some preliminary work on this species both inside and outside of our study area.

Methods

We used Holohil Systems model MD-2C transmitters (164 MHz) on the squirrels and Holohil Systems model BD-2G transmitters on lizards (166 MHz). Beaded chain collars were used to attach the transmitters to the lizards (Harker et al. 1999), while wire and Tygon tubing collars (Holohil Systems) were used on the squirrels. All loci for both the squirrels and lizards were determined on foot using Communications Systems receivers (model R1000) and an H-Adcock or three-element Yagi receiving antenna. We determined the UTM (Universal Transverse Mercator) coordinates of all loci with a GPS receiver (Trimble GeoExplorer 3) with differential and real-time correction. With this unit, we measured a +/- 2-meter variation ($n = 7$) for a single location during the period of our radio tracking. We used the software program RANGES6 to calculate (with default settings) home range areas.

San Joaquin Antelope Squirrels

During the annual small mammal trapping in late July and early August 2002, we attached radio-collars to 20 male antelope squirrels. We only radio-tagged males so that our results would not be confounded by the sex of the animals. We also tried to tag only adults ($\geq$ 130 g in weight), but some subadults (106 g - 129 g) and juveniles ($\leq$ 105 g) were also tagged in order to achieve a sample of about 20 animals (Table 16). Of the four Sections on our study site (21, 27, 29, and 33), we did not tag animals on Section 27 because the high density of kangaroo rats in this area has resulted in minimal difference in residual dry matter between the treatment and control pastures (see 2002 Results section). We, therefore, only collared animals on Sections 21, 29, and 33 (Table 16). All radio-tagged squirrels were recaptured and their collars removed on16 and 17 September 2002.

We attempted to radio-locate each antelope squirrel daily (except weekends), once in the morning and once in the afternoon. We tried to ensure that at least four hours separated the two daily locations to eliminate auto-correlation between loci. We also haphazardly changed the order that individuals were located to eliminate any temporal biases in locations. The diurnal antelope squirrels do not use a "home burrow"; meaning that each night they usually switch to a different burrow. The total number of night burrows is usually between 5 and 10 (G. B. Rathbun, unpublished data). During the day, they range widely over their home ranges and use many burrows as temporary refuges from disturbances, such as biologists radio-tracking them. Thus, all our locations were determined by homing in on animals in burrows rather than by triangulation (Kenward 2001).

<u>Blunt-nosed Leopard Lizards</u>

Because of the low number of blunt-nosed leopard lizards on the study area, and because no leopard lizards have been in control plots since 1999 (see Multiyear Results section), we caught and collared leopard lizards east of the study area across Highway 58 in addition to collaring lizards on the study site. Leopard lizards were found in the study area by driving roads and during two sweeps of Section 27 and part of Section 33 by 5-9 people on foot spaced 10-30 m apart. One sweep by one person was made in Section 29. We concentrated on Sections 27 and 33 because we had seen leopard lizards in these areas in the past two years (see previous annual reports). Leopard lizards east of Highway 58 were found by driving the east/west dirt road at the base of the Elk Hills. We collared 11 blunt-nosed leopard lizards between 17 May and 11 June 2002 in the study site and 8 blunt-nosed leopard lizards between 12 May and 18 June 2002 east of the study area (Table 17). We caught both males and females. Lizards were radio-located once a day, 3-5 times per week. We tracked lizards during daylight, usually in the morning, and we found them most often above ground. A GPS coordinate was taken exactly at the point were the lizard was located. Collars still on lizards at the end of study were removed between 1and 10 July 2002.

Results and Discussion

<u>San Joaquin Antelope Squirrels</u>

We gathered sufficient data to determine home ranges for 19 antelope squirrels; 11 on treatment pastures and 8 that were entirely or mainly on control pastures (Table 18, Figure 24). The average Minimum Convex Polygon home range size using 98% of each individual's loci was 7.38 hectares on the controls and 3.48 hectares on the treatments. These areas are significantly different (two-sample t-Test; two-tail $P = 0.02$). We had expected a difference in home range size between the control and treatment pastures, but not this year. With the very low rainfall on the study area last winter, the difference in residual dry matter between the control and treatment pastures is small (see 2002 Results section). However, there is still more vegetative structure (thatch and standing stems) on the control pastures, which is mostly due to accumulated dry matter from previous wet years. Apparently even these small differences in structure affected home range size in the squirrels. Once we have another wet winter that results in a greater difference in residual dry matter between the pastures, we expect an even greater difference in home range sizes between the control and treatment pastures.

Four of the 19 home ranges were bimodal with two centers of activity separated by an area that was apparently traversed, but not used heavily, by the radio-tagged squirrel (ID #1, 5, 9, and 19; Figure 25). We initially suspected that these separate areas of concentrated use were due to physical features on the study site such as roads or fence-lines between pastures. Indeed one of these bimodal home ranges (#19) was bisected by a boundary between a control and treatment pasture. The other three home ranges, however, seemed to be unrelated to roads or fences. We did not radio-track any females, and we made no attempt to radio-tag all males within an area. We speculate that social interactions among the squirrels resulted in differential use of space by some individuals that we radio-tracked, resulting in the bimodal home ranges.

Blunt-nosed Leopard Lizards

We gathered sufficient data to determine home ranges for 10 blunt-nosed leopard lizards; 7 on the study site and 3 east of the study site (Table 19). Although sample sizes were small for most of these lizards, the Minimum Convex Polygon home range size using 98% of each individual's loci varied between 0.87 and 8.30 hectares for males and 0.93 and 43.9 hectares for females (Tables 20). Although home ranges determined from the fewest locations tended to be the smallest, the three home ranges with > 25 locations varied from 2.41 to 43.9 hectares, and one male with only 17 locations had the largest estimated home range (8.30 hectares) of any males. Similar to home range data for antelope squirrels, 4 of the 10 home ranges were bimodal with two centers of activity separated by an area that was apparently traversed, but not used heavily (ID #1M, 7M, 11M, and 6E).

We encountered two acts of predation on collared blunt-nosed leopard lizards during this study. Female 2M was found inside a northern Pacific rattlesnake (*Crotalus viridis oreganus*) on 5 June 2002, 18 days after the lizard was radio-collared. The rattlesnake was caught, and the lizard's radio transmitter and PIT tag recovered. On 18 June 2002, we found the radio signal of male coming from a high-voltage powerline tower, about 3.2 km from its home range. The signal appeared to be coming from the nest of a red-tailed hawk (*Buteo jaimacensis*) halfway up the 90 m high tower. Adult hawks were circling nearby. We did not recover the transmitter from the nest. Both observations have been written up as a note for *Herpetological Review* and will be published in 2003.

Although the home range data we gathered this year for blunt-nosed leopard lizards is limited, additional years of radio tracking should help illuminate how these lizards are using the study area, including control and treatment plots. We also may be able to determine differences in male and female home ranges with additional data.

Literature Cited

Kenward, R. E. 2001. A Manual for Wildlife Radio Tagging. Academic Press, London. 311 pp.

Germano, D. J. 2003. *Gambelia sila* (Blunt-nosed leopard lizard) Predation. Herpetological Review. In Press.

Harker, M., G. B. Rathbun, and C. A. Langtimm. 1999. Beaded-chain collars: a new method to radiotag kangaroo rats for short-term studies. Wildlife Society Bulletin 27:314-317.

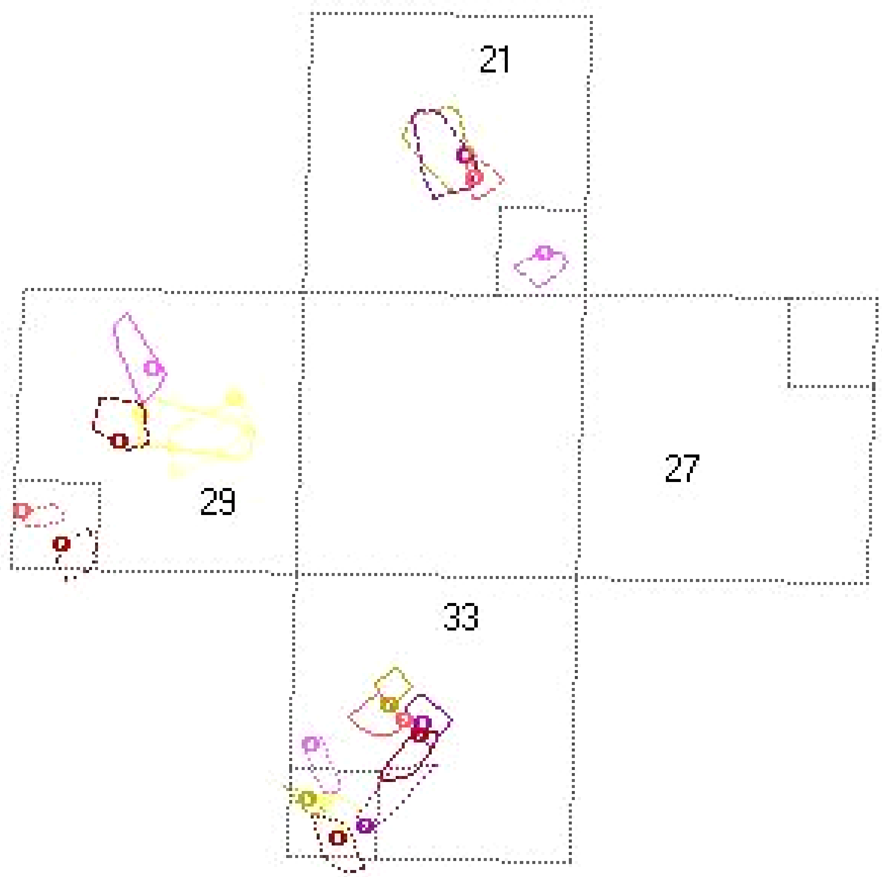


Figure 24. Minimum Convex Polygon home range outlines (98% of loci) for 19 San Joaquin antelope squirrels on the Lokern study site during July - September 2002 (see Tables 16 and 18 for further information). Circles within each home range are initial capture locations. Numbers 21, 27, 29, and 33 are treatment pastures (Sections), and small, imbedded squares are control pastures (500 m on a side).

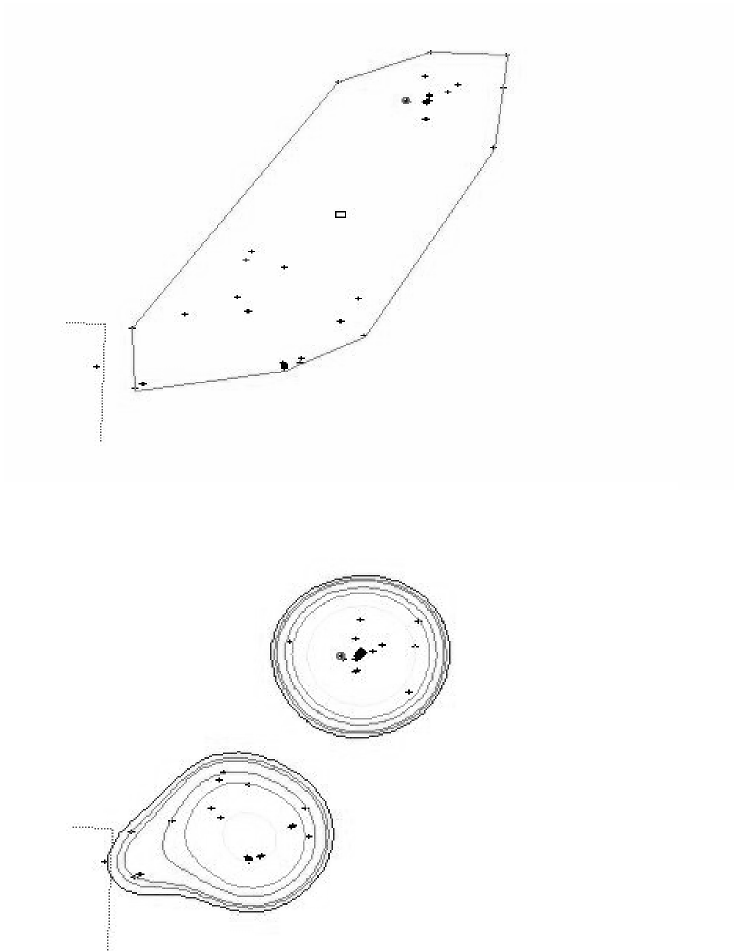


Figure 25. Home range of San Joaquin antelope squirrel #1 (see Table 18 for details). Top: Minimum Convex Polygon (98% of loci). Bottom: Kernel contours at 50%, 75%, 90%, 95%, 98%, and 100% of loci. Dotted line in lower left corner is northeast corner of control pasture in Section 33 (see Figure 24). Within home range, crosses are individual loci, single rectangle is arithmetic mean, and green circle is capture locus.

Table 16. Capture data for San Joaquin antelope squirrels radio-tracked on the Lokern study area during July-September 2002. In the final weight column "Lost" refers to

animals that shed their collars (including due to predation), and a "?" indicates no final weight was taken. Age classes are based on weights: juvenile (J) = ≤ 105 g; subadult (S) = 106 g to 129 g; adult (A) = ≥ 130 g.

ID	PIT Number	Plot	Capture Date	Transmitter Frequency	Start Weight (g)	Final Weight (g)	Age Class
1	414E032103	33T		164.122	142	136	A
2	414D690658	33T		164.143	140	148	A
3	414D6A1F30	33T		164.269	153	150	A
4	414E167D2C	33T		164.440	159	Lost	A
5	414E12093E	29T		164.915(.174)	98	92	J
6	424E552516	29T		164.648(.511)	111	111	S
7	414E03634E	29T		164.503	95	93	J
11	424B1A0E35	29T		165.519	143	Lost	A
8	4348732F53	21T		164.226	111	115	S
9	414E110432	21T		164.254	153	139	A
10	432B095A7D	21T		164.570	103	Lost	J
13	414D6A7964	33C		165.585	139	?	A
14	414F203C02	33C		164.452	134	?	A
15	442C5D7244	33C		164.636	122	121	S
18	414E59447D	33C		164.543	153	?	A
19	432E4B1745	33C		164.346	139	129	A
16	442D43111D	29C		164.421	118	Lost	S
17	442E2F1965	29C		164.613	105	?	J
20	414F147B01	29C		164.282	158	148	A
12	432C052F54	21C		164.382	112	?	S

Table 17. Capture data for blunt-nosed leopard lizards radio-tracked on the Lokern during July-October [Dave - dates correct here?]2002. Area column indicates the location of each animal: "East" = east side of Highway 58, numbers refer to Sections in main study site. Lizards east of Highway 58 were not PIT tagged. In the final weight column "Lost" refers to animals that shed their collars (including due to predation), and a "?" indicates no final weight was taken.

ID	PIT Number	Area	Capture Date	Transmitter Frequency	Start Weight (g)	Final Weight (g)	Sex
1M	414F130D54	27	5-17-02	166.385	34.4	?	M
2M	4233490940	27	5-18-02	166.544	28.6	a	F
3M	422F0F1D5E	27	5-18-02	166.505	32.9	Lost	M
5M	42363A3A7B	33	5-18-02	166.630	30.8	?	M
6M	434A2F7A4C	27	6-7-02	166.505	31.3	31.2	M
7M	434A7E551D	27	6-7-02	166.423	56.1b	59.7b??	F
8M	43674A3A7B	27	6-8-02	166.346	23.9	Lost	F
9M	4348250770	27	6-8-02	166.319	30.6	32.4	F
10M	4368003652	27	6-8-02	166.868	41.3	Lost	M
11M	434A5D0B16	27	6-8-02	166.782	34.7	44.9	M
12M	43677C4A0E	27	6-11-02	166.582	30.0	30.0	F
1E	---	East	5-12-02	166.583	46.8	Lost	M
2E	---	East	5-14-02	166.370	48.9	Lost	M
3E	---	East	5-17-02	166.467	29.6	Lost	F
4E	---	East	5-23-02	166.744	53.6	c	M
5E	---	East	6-4-02	166.824	42.1	Lost	M
6E	---	East	6-4-02	167.069	42.7	37.4	M
8E	---	East	6-4-02	166.666	45.1	?	M
9E	---	East	6-18-02	166.544	43.8	?	F

a – found dead inside a western rattlesnake 5 June 2002b – carrying 3 large eggs
c – transmitter in red-tailed hawk's nest 18 June 2002

Table 18. Home range areas for San Joaquin antelope squirrels on the Lokern study site during July - September 2002. Pastures column indicates the home range location of each animal: "T" = treatment, "C" = control, and "B" = mainly control but also treatment. Home ranges are in hectares using the Minimum Convex Polygon (MCP) and Kernal (K) procedures of the software program RANGES6, for 95%, 98%, and 100% of locations for each individual.

ID	Age Class	Pasture	Sample Size	MCP 95%	MCP 98%	MCP 100%	K 95%	K 98%	K 100%
1	A	T	46	4.35	4.39	4.49	4.56	4.91	5.47
2	A	T	47	2.26	2.27	2.48	2.29	2.60	3.44
3	A	T	45	4.24	4.45	5.26	6.99	7.83	9.32
4	A	T	17	4.31	4.69	4.69	6.22	10.15	10.15
5	J	T	42	14.29	14.48	14.59	13.10	17.38	17.56
6	S	T	46	5.82	7.19	8.47	7.94	10.26	10.49
7	J	T	48	5.33	6.56	6.59	6.09	7.28	9.02
8	S	T	46	10.77	11.92	12.19	15.30	15.77	18.50
9	A	T	42	11.57	11.64	12.77	12.52	14.03	16.67
10	J	T	21	2.43	2.86	2.86	3.69	3.85	3.85
11	A	T	19	8.35	10.81	10.81	16.75	22.26	22.26
12	S	C	32	3.35	3.42	3.43	4.21	4.34	6.15
13	A	B	28	5.27	5.27	5.98	7.14	7.14	7.76
14	A	C	26	1.28	1.28	1.28	2.39	2.39	2.40
15	S	B	29	6.37	6.37	7.20	11.68	11.68	15.72
17	J	C	34	1.80	1.85	1.87	2.62	2.74	3.20
18	A	C	28	2.48	2.48	2.95	3.71	3.71	5.15
19	A	B	27	3.28	3.28	3.32	4.52	4.52	4.61
20	A	C	33	3.03	3.89	4.07	4.40	5.56	5.87

Table 19. Home range areas for blunt-nosed leopard lizards on the Lokern during May - July 2002. Area column indicates the home range location of each animal: "East" = east side of Highway 58, numbers refer to Sections in main study site. Lizards with insufficient numbers of locations (< 15) were excluded. Home ranges are in hectares using the Minimum Convex Polygon (MCP) and Kernal (K) procedures of the software program RANGES6, for 95%, 98%, and 100% of locations for each individual.

ID	Sex	Area	Sample Size	MCP 95%	MCP 98%	MCP 100%	K 95%	K 98%	K 100%
1M	M	27	30	2.41	2.41	2.64	2.80	2.95	3.46
5M	M	33	31	3.81	4.97	5.11	4.09	4.93	5.65
6M	M	27	16	0.60	1.01	1.01	0.93	0.93	0.93
7M	F	27/22	25	43.1	43.9	43.9	45.8	45.8	54.7
8M	F	27	17	0.93	0.93	0.93	1.61	1.63	1.63
11M	M	27	17	7.51	8.30	8.30	12.0	12.0	12.0
12M	F	27	15	1.68	2.05	2.05	4.08	4.51	4.51
2E	M	East	15	0.87	1.39	1.39	1.86	2.08	2.08
6E	M	East	19	1.95	2.71	2.71	1.76	1.80	1.80
8E	M	East	15	0.54	0.87	0.87	1.11	1.84	1.84

Funding

We have raised nearly $310,000 in cash for this research since 1997. This figure does not include nearly an equal amount of in-kind contributions from cooperators. It costs about $65,000 in cash per year (see below) to maintain the study site and carry out the sampling, which does not include on-going commitments for in-kind support. At present, we have funds to cover costs through 2003. We do not yet have sufficient funds for 2004 and beyond. As in the past, we will be relying on contributions from all of the participants to meet future funding needs.

Yearly Expenditures (does not include in-kind contributions):

Item	Cash Amount
Calif. State Bakersfield Foundation	$35,000
End. Species Recovery Program; Plant Studies	$15,000
WERC, San Diego	$7,000
Vehicle	$3,000
Travel	$3,000
Field Supplies/Repairs	$2,000
Total	$65,000
Radio Tagging Study (funded by Occidental of Elk Hills, Inc.)	$21,000

Cooperators

The Bureau of Land Management (BLM) has been the principal "client" of the Lokern Project, and their needs have driven much of the planning and design of the study. Numerous other agencies and organizations have realized that the research has broad applicability to their lands and interests, and they have participated in various aspects of the project.

In addition to USGS and BLM, the main supporters and participants in the Lokern Project include the Endangered Species Recovery Program (ESRP); the US Fish and Wildlife Service (USFWS); the California Department of Fish and Game (CDFG); the California State University, Bakersfield (CSUB); the Center for Natural Lands Management (CNLM); The National Fish and Wildlife Foundation (NFWF); the California Department of Water Resources (CDWR); Chevron Oil Company; ARCO Oil Company; Occidental of Elk Hills, Inc.; Safety Kleen Environmental Services; and Eureka Livestock Company.

The following investigators have been responsible for implementing the different aspects of the Lokern research. These scientists have also contributed summaries of data for this annual report:

Dr. Ellen Cypher, Research Ecologist, Endangered Species Recovery Program, PO Box 9622, Bakersfield, CA 93389-9622. Phone 661/398-2201. Ecypher@esrp.org. ***Vegetation and rare plant studies.***

Mr. Sam Fitton, Wildlife Biologist, Bureau of Land Management, 20 Hamilton Court, Hollister, CA 95023. Phone 831/830-5000. Sfitton@ca.blm.gov. ***Bird studies.***

Dr. David Germano, Associate Professor, Department of Biology, California State University, Bakersfield, CA 93311-1099. Phone 661/589-7846. Dgermano@csub.edu. ***Lizard, mammal, and invertebrate studies. Project coordination, report coordination and preparation. Blunt-nosed leopard lizard radio tagging study.***

Dr. Galen Rathbun, Research Biologist, Department of Ornithology and Mammalogy, California Academy of Science, Golden Gate Park, San Francisco, c/o P.O. Box 202, Cambria, CA 93428. Phone 805/927-3893. Grathbun@calacademy.org. ***Mammal and invertebrate studies, San Joaquin antelope radiotagging study.***

Mr. Larry Saslaw, Wildlife Biologist, Bureau of Land Management, 3801 Pegasus Drive, Bakersfield, CA 93308. Phone 661/391-6086. Lawrence_Saslaw@ca.blm.gov. ***Plot, soil moisture, and cattle studies.***

In addition, the following people and agencies assisted with field work: Kathy Sharum, John Moule, and James Mann, BLM; Greg Warrick, Center for Natural Lands Management; Lisa Lyren and Greta Turschak, USGS; Rochelle Germano, Damien Germano, Alex Brown, Paula Do, Justin Brown, Julian Valenzuala, and Belen Perez, CSU Bakersfield Foundation. We greatly appreciated the assistance from the following volunteers that participated in fieldwork: Joel Saslaw. Funding for Dr. Cypher was provided by ESRP and a LEGACI grant from the Great Valley Center.